

Deer Population Modeling

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Introduction



- Managers set qualitative management objectives
 - Increase, Decrease, Maintain
- Need a quantifiable way to ensure we are working towards the desired management objective
 - Population Modeling
- Is the population growing? How fast? How can we get it to grow faster? Slower? Not grow at all?
- Through a collaborative effort with the University of Montana (UM) we developed modeling software PopR
- PopR brings a consistent set of state of the art statistical tools to all SDGFP managers
- PopR includes Bayesian integrated population models (IPM) combining multiple sources of data into a single population projection model



Integrated Population Modeling

- Bayesian Statistics
 - Probability of A given B
 - Probability of population growth or decline given survival, reproductive rates, herd composition and harvest
 - All while dealing with uncertainty using prior distributions
 - Allows us to quantify multiple population metrics
- IPM describes biological change within a deer population through time
 - 3 age-class matrix model including both male and female
 - Fawns (0-4 months), Juveniles (5-16 months) and Adults (16+ months)
- Facilitates prediction and proactive management, which does away with qualitative opinion based management prescriptions





South Dakota's Combined Deer Harvest 1975-2015

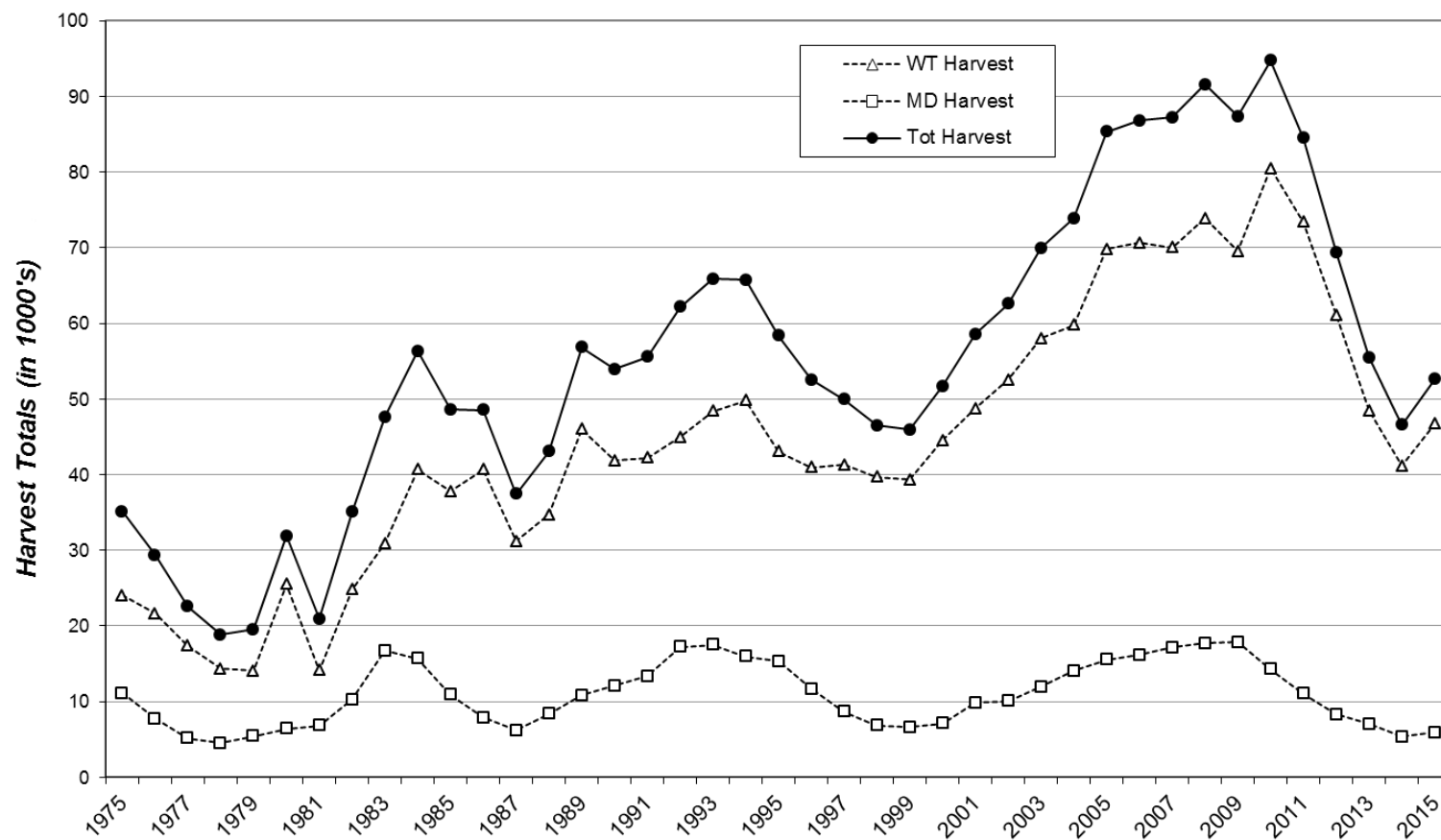


Figure 1. Estimated deer harvest by species, 1975-2015

PopR Database Structure



Sequel Database



Raw field data

Data travels through
API connection and
uploaded into PopR

Capture,
Monitoring and
Mortality records,
Herd Composition,
Pregnancy, and
Harvest data

PopR multi-
level analyses
(Species, DAU,
Unit, Year, Sex
and Age)

Demographic
Estimates (e.g., survival)
Data integrity checks,
view and query data,
generate summary
reports

Model Runs

Integrated
population
model
estimates
(DAU level)

Abundance and
Summary Data
Report Generation

PopR Population Reconstruction



- How does the model formulate an abundance estimate?
- Annual survival (**s**) (Derived from radio-collared deer)
- Hunter harvest mortality rate [**(hm)**]-the proportion of total mortality caused from hunter harvest] (Derived from radio-collared deer)
- Harvest (**h**) (total harvest of all user groups combined)
- Pre-hunt population estimate (**N**) is formulated for DAU x using the formula:
$$N = ((h)/(hm)) / (1-s)$$
 - Example:
 - Lets say we harvest 1000 deer from DAU x ($h = 1000$)
 - During that year, of the 100 radio-collared deer in that DAU, 80% survived; thus 20% died ($s = 0.8$)
 - Of the 20 that died, 10 died from hunter harvest
 - $10/20 = 50\%$ hunter harvest mortality rate ($hm = 0.5$)
 - How many total deer died including all mortality sources?
 - $= (h)/(hm) = 1000 \text{ harvested deer} / 0.5 \text{ (hunter harvest mortality rate)} = 2000$
 - How many deer did we start with?
 - $= ((h)/(hm)) / (1-s) = 2000 \text{ (number that died)} / ((1-0.8) = 0.2) = 10,000 \text{ deer}$
 - $10,000 - 2000 = 8,000$ survived



PopR Population Projection

- Once an abundance estimate is derived, is the population increasing, decreasing or remaining stable?
- Dependent upon:
- Survival of all sex and age categories by species
 - Mule Deer & White-tailed Deer
 - Male and Female- fawn, juvenile and adult
- Pregnancy rates and fetus counts of juvenile and adult females
- Herd Composition
 - Buck/Doe Ratios; Fawn/Doe Ratios
- Changes in hunter harvest rates





Population Projections

Fall Herd Composition	80 Fawns: 100 Does		90 Fawns: 100 Does		100 Fawns: 100 Does	
Over-winter Fawn Survival	0.6	0.8	0.6	0.8	0.6	0.8
Annual Adult Female Survival						
0.7	↓	↑	●	↑	↑	↑↑
0.8	↑	↑↑	↑	↑↑	↑↑	↑↑↑
0.9	↑↑	↑↑↑	↑↑	↑↑↑	↑↑	↑↑↑↑

Rates of Change

↓: .90 - .99 ●: .99 – 1.01 ↑: 1.01 - 1.10 ↑↑: 1.10 – 1.20 ↑↑↑: 1.20 -1.30 ↑↑↑↑: 1.3+

Predicted deer population trends (decrease [↓], stable [●], increase [↑]) based on adult female (>2 years) survival and over-winter (October - May) fawn survival in relation to September - October fawn:doe ratios.



Population Projections

Fall Herd Composition	50 Fawns: 100 Does		60 Fawns: 100 Does		70 Fawns: 100 Does	
	0.6	0.8	0.6	0.8	0.6	0.8
Over-winter Fawn Survival						
Annual Adult Female Survival						
0.7	↓↓	↓	↓	●	↓	↑
0.8	↓	●	●	↑	●	↑↑
0.9	●	↑	↑	↑↑	↑	↑↑↑

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Explore PopR Website



- Survival
- Pregnancy
- Herd Composition
- Harvest
- DAU
- IPM
 - [Summary Report](#)



Management Implications



- How do different tag allocations impact population growth rates?
 - Assume additional harvest is additive
 - Potential number of animals added or removed from the population is derived from the previous 3-year average success rates for that tag type



- This function allows wildlife managers to manipulate future harvest strategies to assess potential population-level effects.



Summary

- Population trajectories are an important management tool that enables justification for future harvest strategies dependent upon management objectives.
- Understanding population rates of change allows managers to implement proactive management recommendations while practicing adaptive management techniques.



